10-02-00

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Practitioner's Docket No. 9792909-4642 ***PATENT***

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Refile

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Tadashi Taniguchi et al.

For (title): OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS

1. Type of Application

This transmittal is for a divisional application.

2. Benefit of Prior U.S. Application (35 U.S.C. sections 119(e), 120, or 121)

The new application being transmitted claims the benefit of prior U.S. application. Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

14 Page(s) of Specification
7 Page(s) of Claims

B. Other Papers Enclosed
2 Page(s) of declaration and power of attorney from parent application
1 Page of abstract
1-Page of Added Pages For Claiming Benefit Of An Earlier Filing Date

4. Additional Papers Enclosed

Preliminary Amendment
Copy of Cover Page of Certified Copy

5. Declaration or Oath

Copy of prior Declaration submitted pursuant to 37 C.F.R. 1.63(d).
Executed by: inventors.

6. Language

English

7. Assignment

An assignment of the invention to Sony Corporation is attached as the assignment of the original application carries title to a continuation application pursuant to MPEP § 201.12 and MPEP § 306.

8. Fee Calculation (37 C.F.R. section 1.16)

Regular Application

CLAIMS AS FILED					
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 CFR 1.16(a) $690.00
Total Claims (37 CFR 1.16(c))	13	- 20 =	0 x	$18.00	$0.00
Independent Claims (37 CFR 1.16(b))	11	- 3 =	8 x	$78.00	$624.00
Multiple Dependent Claim(s), if any	(37 CFR 1.16(d))			+	$260.00

$0.00

Filing Fee Calculation $1314.00

9. Fee Payment Being Made at This Time

EnclosedFiling Fee $690.00

Total Fees Enclosed $1314.00

10. Method of Payment of Fees

Check in the amount of $1314.00 is attached.

11. Authorization to Charge Additional Fees

The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 19-3140.

12. Instructions as to Overpayment

Refund.

ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED

13. Relate Back--35 U.S.C. SECTION 119 Priority Claim for Prior Application

The present application claims priority from U.S. serial no. 09/473,007 filed on 12/28/99, which is a continuation of U.S. Serial No. 08/863,434 filed on 05/27/97

The prior U.S. application(s), including any prior International Application designating the U.S., identified above in the section entitled, "Relate Back--35 U.S.C. SECTIONS 120, 121 and 365(c)," in turn itself claim(s) foreign priority(ies) as follows:

Country	Application Number	Filed
JAPAN	P08-154839	05/27/96

The certified copy has been previously filed.

14. Correspondence

Please send all correspondence to the address indicated below.

Date: Sept 28, 2000

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Tadashi Taniguchi, et al.	ATTORNEY DOCKET NO: 09792909-4642
SERIAL NO.		GROUP ART UNIT:
FILING DATE:		EXAMINER:
INVENTION:	"OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS"	

which is a Divisional of copending Application of the following U.S. Application

APPLICANT:	Tadashi Taniguchi, et al.	OLD ATTORNEY DOCKET NO: P99.2662 NEW ATTORNEY DOCKET NO: 09792909-4480
SERIAL NO.	09/473,007	GROUP ART UNIT: 2753
FILING DATE:	December 28, 1999	EXAMINER: N. Hindi
INVENTION:	"OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS"	

Honorable Commissioner of
Patents and Trademarks
Washington D.C. 20231

EXPRESS MAIL CERTIFICATE OF MAILING

Express Mail" Mailing Label Number EL370090010US
Date of Deposit Sepetember 28, 2000

I hereby certify that the following items are being deposited with the United States Postal Services "Express Mail Post Office to Addressee" Service Under 37 CFR 1.10 on the date indicated above and is addressed to The Commissioner of Patents and Trademarks, Washington, D.C. 20231:

1. Divisional U.S. Patent Application
2. Utility Patent Application Transmittal
3. Copy of Specification (22 sheets)
4. Drawings (11 sheets)
5. Preliminary Amendment
6. Copy of Declaration
7. Copy of Assignment
8 Check $1314
9. Postcard

Anna Fram
Signature of Person Mailing Application and Fees

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: Tadashi Taniguchi, et al.	ATTORNEY DOCKET NO: 9792909-4642
SERIAL NO.	GROUP ART UNIT:
FILING DATE:	EXAMINER:
INVENTION: "OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS"	

which is a Divisional of copending Application of the following U.S. Application

APPLICANT: Tadashi Taniguchi, et al.	OLD ATTORNEY DOCKET NO: P99,2662
	NEW ATTORNEY DOCKET NO: 09792909-4480
SERIAL NO. 09/473,007	GROUP ART UNIT: 2753
FILING DATE: December 28, 1999	EXAMINER: N. Hindi
INVENTION: "OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS"	

PRELIMINARY AMENDMENT

Asst. Commissioner of Patents
Washington, D.C. 20231

S I R:

Please enter the following amendment prior to examination of the above-identified patent application.

IN THE SPECIFICATION

Between the title and the heading "Background of the Invention" insert the following:

--RELATED APPLICATION DATA

This application is a divisional of copending application Serial No. 09/473,007 filed December 28, 1999, New Attorney Docket No. 09792909-4642, Old Attorney Docket No. P99,2662, which is a continuation of application Serial No. 08/863,434 filed May 27, 1997. The present and foregoing applications claim priority to Japanese application No. P08-

154839 filed May 27, 1996. All of the foregoing applications are incorporated herein by reference to the extent permitted by law.--

IN THE CLAIMS

Please cancel claims 1-9, 11, 15-18, 20-21, 23, 27-34, 36-37 and 39 without prejudice or disclaimer.

Please amend the claims as follows:

12. (Amended) [The composite optical device according to claim 6, wherein] A composite optical device comprising:

a plurality of light emitting elements, a photodetector element and a transparent optical element having a partial reflective plane that are provided on a base body, said light emitting elements having different read/write specifications,

said light emitting elements [are] being arranged to share a common optical axis and to share a common reflective plane of said optical device.

13. (Amended) [The composite optical device according to claim 6, wherein] A composite optical device comprising:

a plurality of light emitting elements, a photodetector element and a transparent optical element having a partial reflective plane that are provided on a base body, said light emitting elements having different read/write specifications,

said light emitting elements [are] being disposed at different heights from [the] a surface of said base body.

14. (Amended) [The composite optical device according to claim 6, wherein] A composite optical device comprising:

a plurality of light emitting elements, a photodetector element and a transparent optical element having a partial reflective plane that are provided on a base body, said light emitting elements having different read/write specifications,

said light emitting elements [are] being arranged to share a common optical axis and to share [a part of] said photodetector element.

19. (Amended) [The optical pickup device of claim 16, wherein there are two photocouplers and the] An optical device comprising two photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats,

the photocouplers [share] sharing a common half mirror such that one photocoupler is aligned with the axis of [the] direct light passing through the half mirror while the other photocoupler is aligned with the axis of incident light reflected by the half mirror.

22. (Amended) [The optical pickup device of claim 20, wherein] An optical device comprising two photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, wherein said optical pickup device has a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the prism [has] having a plurality of reflecting surfaces and the photocouplers [use] using different reflecting surfaces of the prism.

24. (Amended) [The optical pickup device of claim 20, wherein] An optical device comprising two photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, said optical pickup device [having] has a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the photocouplers [are] being positioned in over-and-under relationship.

25. (Amended) [The optical pickup device of claim 20, wherein] An optical device comprising two photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, said optical pickup device having a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the photocouplers [are] being positioned in confronting relationship on opposite sides of the prism.

26. (Amended) The optical pickup device of claim 25, wherein the photocouplers comprise photo diodes located under the prism and the photocouplers are operatively interconnected so as to share in common the photo diodes located under [said] the prism.

35. (Amended) [The optical disc system of claim 32,] An optical disc system comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, a circuit for driving said optical device and a selector for selecting between said composite optical devices, wherein there are two photocouplers and the photocouplers share a common half mirror such that one photocoupler is aligned with the axis of the direct light passing through the half mirror while the other photocoupler is aligned with the axis of incident light reflected by the half mirror.

38. (Amended) [The optical disc system of claim 36, wherein] An optical disc system comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, a circuit for driving said optical device and a selector for selecting between said composite optical devices, said optical pickup device having a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the prism [has] having a plurality of reflecting surfaces and the photocouplers [use] using different reflecting surfaces of the prism.

40. (Amended) [The optical disc system of claim 36, wherein] An optical disc system comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, a circuit for driving said optical device and a selector for selecting between said composite optical devices, said optical pickup device having a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the photocouplers [are] being positioned in over-and-under relationship.

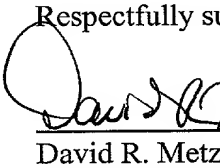
41. (Amended) [The optical disc system of claim 37, wherein] An optical disc system comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, a circuit for driving said optical device and a selector for selecting between said composite optical devices, said optical pickup device having a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium, the photocouplers [are] being positioned on confronting relationship on opposite sides of the prism.

42. (Amended) The optical disc system of claim 41, wherein the photocouplers comprise photo diodes located under the prism and the photocouplers are operatively interconnected so as to share in common the photo diodes located under [said] the prism.

REMARKS

The above amendments are being made to set forth claims upon which this divisional application is based.

Respectfully submitted,



, Reg. 32,919

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SPECIFICATION

TITLE

OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS

BACKGROUND OF THE INVENTION

The invention relates to optical pickup devices and composite optical devices especially suitable for use in an optical disc system.

Along with the recent diversification of optical disc systems, there has been an increase in incompatible optical discs using what are referred to herein as different read/write formats (or simply formats) (for example, CD, CD-R, MD, MO, Phase Change Disc DVD, and so on). These read/write formats can very, e.g., by using laser light from a semiconductor laser for emitting light in the band of 780 nm, laser light from an emitting semiconductor laser for emitting red light in the band of 635 nm (or 650 nm), laser light from a semiconductor laser for emitting blue light, and so forth. The optical pickup devices used to read from and write to these different optical recording media then have what are referred to herein as different read/write specifications.

In order to use a common optical disc system to record and reproduce signals wit different kinds of optical discs having different formats, a system needs different optical pickup devices for respective optical discs having different read/write formats.

On the other hand, considering the large differences in purpose and characteristics between writing semiconductor lasers and reading semiconductor lasers, it would be easier for making an optical pickup device, in some applications, to use a semiconductor laser only for writing and another semiconductor laser for reading.

However, the use of different optical pickup devices for respective optical discs of different formats invites an increase in the dimensions and cost of the optical disc system. Especially when a packaged writing semiconductor laser and a

packaged reading semiconductor laser are used to make up an optical pickup device, the optical pickup device itself, and an optical disc system using it, become more bulky. At the same time, these semiconductor lasers and photodetector elements are difficult to assemble because adjustment of their optical axes is more difficult than conventional devices.

SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide an optical pickup device that can be used for both reading from and writing to different kinds of optical discs having different read/write formats, and yet has a small-scaled, easily assembled structure.

Another object of the invention is to provide a composite optical device that can be used for both reading from and writing to different kinds of optical discs having different read/write formats when used in an optical pickup device, and contributes to miniaturization and easier assembly of the optical pickup device.

According to a first aspect of the invention, there is provided an optical pickup device comprising:

a plurality of a composite optical devices, each having a light emitting element, a photodetector element and a transparent optical element with a partial reflective plane that are supported on a base body, the composite optical devices having different read/write specifications..

Typically, the light emitting elements are different from each other in light emitting wavelength and/or optical output power. Each light emitting element, photodetector element and transparent optical element typically is arranged so that the optical axis of exist light from the light emitting element and the optical axis of incident light to the photodetector element substantially coincide on the partial reflective plane of the transparent optical element.

According to another aspect of the invention, there is provided a composite optical device comprising:

a plurality of light emitting elements, a photodetector element and a transparent optical element having a partial reflective plane that are provided on a base body, the light emitting elements having different read/write specifications.

Typically, the light emitting elements are different from each other in light emitting wavelength and/or optical output power. Each light emitting element, photodetector element and each transparent optical element are typically arranged so that the optical axis of exit light from the light emitting element and the optical axis of incident light to the photodetector element substantially coincide on the partial reflective plane of the transparent optical device.

The optical pickup device having the above construction according to the invention can be used for both reading of and writing to different kinds of optical discs having different formats by designing its composite optical devices to have specifications in accordance with the different kinds of optical discs. Since the composite optical devices can be miniaturized, the optical pickup device also can be small-scaled. Moreover, since light emitting elements, photodetectors and transparent optical elements in the composite optical devices are previously adjusted in optical axis, etc., the optical pickup device can be assembled easily.

The composite optical device having the above construction according to the invention can be used for both writing to and reading of different kinds of optical discs having different formats by designing individual light emitting elements to have specifications in accordance with the different kinds of optical discs. Since the composite optical device can be miniaturized, a miniaturized optical pickup device can be made by using the optical pickup device. Moreover, since optical axes, etc. of light emitting elements, photodetectors and transparent optical elements in the composite optical devices can be adjusted easily like those of a conventional composite optical device having a single light emitting element, they can be assembled easily.

These and other features of the invention are discussed in greater detail below in the following detailed description of the presently preferred embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a typical laser coupler used in an optical pickup device according to a first embodiment of the invention.

Fig. 2 is a cross-sectional view showing a typical laser coupler used in an optical pickup device according to the first embodiment of the invention.

Fig.3 is a plan view showing a pattern of photodiodes for detecting optical signals in the laser coupler shown in Figs. 1 and 2.

Fig. 4 is a perspective view showing a laser coupler packaged in a flat package.

Fig. 5 is a schematic diagram for explaining behaviors when a laser coupler is applied to an optical pickup device.

Fig. 6 is a schematic diagram showing a laser coupler according to the first embodiment of the invention.

Fig. 7 is a perspective view showing a laser coupler according to a second embodiment of the invention.

Fig. 8 is a perspective view showing a laser coupler according to a third embodiment of the invention.

Fig. 9 is a perspective view showing a laser coupler according to a fourth embodiment of the invention.

Fig. 10 is a perspective view showing a laser coupler according to a fifth embodiment of the invention.

Fig. 11 is a perspective view showing a laser coupler according to a sixth embodiment of the invention.

Fig. 12 is a perspective view showing a laser coupler according to another embodiment of the invention.

Fig. 13 schematically illustrates an optical disc system employing principles of the invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Embodiments of the invention are explained below with reference to the drawings. Identical or equivalent elements or parts are labeled with common reference numerals in all figures of the drawings. However, it should be noted that a laser coupler is a kind of a composite optical device.

Figs. 1 and 2 show a laser coupler, which is a type of a composite optical device. Fig. 1 is a perspective view of the laser coupler, and Fig. 2 is a cross-sectional view of the laser coupler taken along its lengthwise direction.

As shown in Figs. 1 and 2, the laser coupler includes a microprism 2 made from optical glass and a LOP (Laser On Photodiode) chip having a semiconductor laser 4 supported on a photodiode 3 which are mounted in close locations on a photodiode IC 1. The photodiode IC 1 incorporates a pair of photodiodes PD1, PD2 and other well known elements (not shown) such as a current-to-voltage converting amplifier, an operational processing circuit, and so on. The photodiode 3 is used to monitor optical outputs from the rear end surface of the semiconductor laser 4 and to control optical output power from the front end surface of the semiconductor laser 4. Since the semiconductor laser 4 is mounted so as to locate its junction downward in most cases, the photodiode 3 also functions to support the semiconductor laser 4 sufficiently high above the surface of the photodiode IC 1 to prevent that the laser beam emitted from the front end surface of the semiconductor laser 4 is reflected by the surface of the photodiode IC 1 and becomes noise light.

As shown in Fig. 2, the microprism 2 has a sloped surface 2a, a top surface 2b, a bottom surface 2c, and surfaces 2d and 2e. The sloped surface 2a has a half mirror 5, the top surface 2b has a total reflective film 6, the bottom surface 2c has an antireflection coating 7, the end surface 2d is a polished surface, and the end surface 2e has a light absorption film 8. A typical dimension of the microprism 2 is 0.6 mm in height, 1.52 mm in total length, 1.8 mm in width and 1.1 mm in length of the top surface 2b.

Further formed on the antireflection coating 7 on the bottom surface 2c of the microprism 2 is a silicon dioxide (SiO_2) film (not shown). On the other hand, formed on the photodiode PD1 of the photodiode IC 1 is a silicon nitride (SiN) film (not shown). Another SiO_2 film 9 overlies the SiN film and the photodiode PD2. The microprism 2 is mounted on the photodiode IC 1 by bonding the SiO_2 film on the bottom surface 2c of the microprism 2 to the SiO_2 film 9 on the photodiode IC 1 with an adhesive 10. In this case, the SiN film on the photodiode PD1 and the overlying portion of the SiO_2 film 9 form a half mirror. The SiO_2 film on the antireflection coating 7 reinforces the adhesive force of the microprism 2 by the adhesive 10. The SiO_2 film 9 passivates the surface of the photodiode IC 1 and reinforces the adhesive force of the microprism 2 by the adhesive 10.

The photodiodes PD1 and PD2 for detection of optical signals may be of a quarter divisional type. That is, as shown in Fig. 3, the photodiode PD1 has four photodiodes A1 to A4 separated from each other, and the photodiode PD2 has four photodiodes B1 to B4 separated from each other.

As shown in Fig. 4, the laser coupler having the above construction is contained in a flat package 11, which may be made from ceramics, and is sealed by a window cap (not shown).

Not explained are behaviors of the laser coupler with reference to Fig. 5. The laser light L emitted from the front end surface of the semiconductor laser 4 is reflected back by the half mirror (now shown) on the slope surface 2a of the microprism 2, then converged by the objective lens OL, and enters onto the optical disc D. The objective lens OL may be integral with or a separate body from the laser coupler. The laser light L reflected by the optical disc D enters into the interior of the microprism 2 through the half mirror on the slope surface 2a of the microprism 2. One half (50%) of the light entering into the microprism 2 enters into the photodiode PD1, and the other half (50%) is reflected by the half mirror on the photodiode PD1 and the top surface 2b of the microprism 2 successively, and then enters into the photodiode PD2.

Although the laser coupler is designed so that the spot size of the laser light L on the photodiode PD1 and that on the photodiode PD2 coincide when the laser light L is focalized onto the record plane of the optical disc D, these spot sizes on the photodiodes PD1 and PD2 gradually differ as the focalized position deviates from the record plane due to a movement of the optical disc D. Therefore, if any difference between an output signal from the photodiode PD1 and an output signal form the photodiode PD2 is regarded as a deviation in focalized position, a focus error signal can be detected. By determining the zero value of the focus error signal to indicate proper focalization on the optical disc D, namely, the just focus point, an actual focus error signal is fed back to the focus servo system to adjust subsequent focus error signals to zero. In this manner, proper focalization is maintained to ensure satisfactory record and reproduce operations of the optical disc D. In Fig. 3, the focus error signal is made from (A1+A2+B3+B4)-(A3+A4+B1+B2).

Based on the description made above, a first embodiment of the invention is explained below. In this embodiment, two laser couplers explained above are used to form an optical pickup device.

Fig. 6 shows the optical pickup device according to the first embodiment of the invention.

As shown in Fig. 6, the optical pickup device according to the first embodiment is made up of two laser couplers LC1 and LC2, half mirror HM and objective lens OL. The laser couplers LC1 and LC2 may have the construction shown in Figs. 1 and 2, for example. In this case, the laser coupler LC1 is disposed to share a common optical axis with the half mirror HM and the objective lens OL. The laser coupler LC2 is disposed to substantially coincide its incident or exit optical axis with the incident or exit optical axis of the laser coupler LC1 on the half mirror HM. The half mirror HM preferably has a polarizing function to polarize laser beams from the laser couplers LC1 and LC2 into different polarized beams to attain the maximum use of light.

In the first embodiment, the laser coupler LC1 is designed in accordance with an optimum specification for record and reproduce of a particular kind of optical

discs having a particular format. That is, the light emitting wavelength and/or optical output power of its semiconductor laser 4, photodetective properties of the photodiodes PD1 and PD2, and so forth, are optimized for the particular optical disc. On the other hand, the laser coupler LC2 is designed in accordance with an optimum specification for record and reproduce of another kind of optical discs having a format different from the former one. That is, the light emitting wavelength and/or optical output power of the semiconductor laser 4, photodetective characteristics of the photodiodes PD1 and PD2, etc. are optimized for the other kind of optical disc.

Usable as the semiconductor laser 4 are, e.g., a semiconductor laser for light emitting wavelength in the band of 780 nm and optical output power of several milliwatt, a semiconductor laser for light emitting wavelength in the band of 780 nm and optical output power of decades of milliwatt, a semiconductor laser for emitting red light (light emitting wavelength in the band of 635 to 680 nm, approximately) and optical output power of several milliwatt, a semiconductor laser for emitting red light (light emitting wavelength around 635 to 680 nm) and optical output power of decades of milliwatt, a semiconductor laser for emitting blue light (light emitting wavelength around 500 nm) and optical output power of several milliwatt, and a semiconductor laser for emitting blue light (light emitting wavelength around 500 nm) and optical output power of several milliwatt. Clearly, a laser is selected depending on the purpose.

Since the optical pickup device according to the first embodiment has the laser couplers LC1 and LC2 having optimum specifications for recording onto and reproducing from two kinds of optical discs in different formats, the optical pickup device is available for recording onto and reproducing from two kinds of optical discs in different formats by selectively using one of these laser couplers LC1 and LC2 depending on the format of an optical disc to be recorded or reproduced. Since these laser couplers LC1 and LC2 can be miniaturized, the optical pickup device can be small-scaled. Moreover, since the semiconductor lasers 4, photodiodes PD1, PD2, and microprisms 2 are previously adjusted in optical axis, etc., the optical pickup device can be assembled easily.

Fig. 7 shows a laser coupler taken as a second embodiment of the invention, which is used in an optical pickup device.

As shown in Fig. 7, the laser coupler according to the second embodiment includes two laser couplers LC1 and LC2 having the same construction shown in Figs. 1 and 2 and supported in close locations on a common photodiode IC 1 to orient their optical axes in parallel with each other. Like those in the first embodiment, the laser couplers LC1 and LC2 are individually designed in optimum specifications each for record and reproduce of one kind of optical discs in a particular format.

The distance between the LOP chip of the laser coupler LC1 and the LOP chip of the laser coupler LC2 is typically around 500 um, and 30 to 400 um in minimum, although depending on the mounting accuracy of these LOP chips.

When an optical pickup device is made by using the laser coupler according to the second embodiment, the objective lens may be an integral body with or a separate body from the laser coupler. The laser couplers LC1 and LC2 can commonly use a single objective lens.

Also the second embodiment has the same advantages as those of the first embodiment. That is, when the laser coupler according to the second embodiment is used in an optical pickup device, the optical pickup device is available for recording on and reproducing from two kinds of optical discs in different formats by selectively using one of these laser couplers LC1 and LC2 depending on the format of an optical disc to be recorded or reproduced.

Additionally, since the laser couplers LC1 and LC2 are incorporated into the common photodiode IC 1, the optical pickup device can be miniaturized and can be fabricated economically because a single photodiode IC 1 and a single package are sufficient to make up the optical pickup device. Moreover, adjustment of optical aces upon incorporating the laser couplers LC1 and LC2 on the photodiode IC 1 is relatively easy, like the laser coupler shown in Figs. 1 and 2.

Since the semiconductor lasers 4, photodiodes PD1, PD2 and microprisms 2 are previously adjusted in optical axis, etc., the optical pickup device can be assembled easily.

Fig. 8 shows a laser coupler taken as a third embodiment of the invention, which is used in an optical pickup device.

As shown in Fig. 8, in the laser coupler according to the third embodiment, a single common microprism is used for both laser couplers LC1 and LC2. A single sloped surface 2a is used by both laser couplers LC1 and LC2. In the other aspects, the third embodiment is the same as the laser coupler of the second embodiment, and its explanation is omitted here.

Here again, when an optical pickup device is made by using the laser coupler according to the third embodiment, the objective lens may be an integral body with or a separate body from the laser coupler, and the laser couplers LC1 and LC2 can commonly use a single objective lens.

Also the third embodiment has the same advantages as those of the second embodiment.

Fig. 9 shows a laser coupler taken as a fourth embodiment of the invention, which is used in an optical pickup device.

As shown in Fig. 9, in the laser coupler according to the fourth embodiment, two laser couplers LC1 and LC2 are incorporated in a face-to-face relationship on a common photodiode IC 1 to share common signal detecting photodiodes PD1 and PD2, common microprism 2, and a common optical axis. In this case, the microprism 2 has two oppositely positioned sloped surfaces 2a for receiving incident light, which are slanting down toward respective LOP chips of the microprisms 2, respectively.

In the other aspects, the laser coupler according to the fourth embodiment is the same as the laser coupler according to the second embodiment, and its explanation is omitted here.

In the fourth embodiment, a typical distance between a laser beam L emitted from one of the semiconductor laser 4 and reflected by one of the slope surfaces 2a of the microprism 2 and another laser beam L emitted from the other semiconductor laser 4 and reflected by the other slope surface 2a is about 1 mm.

Here again, when an optical pickup device is made by using the laser coupler according to the fourth embodiment, the objective lens may be integral with or separate from the laser coupler, and both laser couplers LC1 and LC2 may share a common objective lens.

Also the fourth embodiment has the same advantages as those of the second embodiment. In this case, because the laser couplers LC1 and LC2 share the common photodiodes PD1 and PD2 and the common microprism 2, the photodiode IC 1 can be miniaturized more, and also the optical pickup device can be small-scaled more.

Fig. 10 shows a laser coupler taken as a fifth embodiment of the invention, which is used in an optical pickup device.

As shown in Fig. 10, in the laser coupler according to the fifth embodiment, two semiconductor lasers 4 different in light emitting wavelength and/or optical output power from each other are incorporated on a single LOP chip. More specifically, a photodiode chip 3 has a two-step top surface 3a. Formed on a lower step of the two-step top surface a is a semiconductor laser 4 designed for optimum light emitting wavelength and/or optical output power for writing to and reading from the same kind of discs in a particular format. Formed on the higher step of the two-step top surface 3a is another semiconductor laser 4 designed for optimum light emitting wavelength and/or optical output power for write and read of different kinds of optical discs in different formats. The height of the step portion 3a is large enough to prevent interference between laser beams L emitted from the front end surface of both semiconductor lasers 4.

In the other aspects, the fifth embodiment is the same as the laser coupler according to the second embodiment, and its explanation is omitted here.

Here again, when an optical pickup device is made by using the laser coupler according to the fifth embodiment, the objective lens may be integral with or separate from the laser coupler, and both laser couplers LC1 and LC2 may share a common objective lens.

Also the fifth embodiment has the same advantages as those of the second embodiment. In this case, because the laser couplers LC1 and LC2 share the common photodiodes PD1 and PD2, the common microprism 2 and the common microprism sloped surface 2a, the photodiode IC 1 can be miniaturized more, and also the optical pickup device can be small-scaled more.

Fig. 11 shows a laser coupler taken as a sixth embodiment of the invention, which is used in an optical pickup device.

As shown in Fig. 11, in the laser coupler according to the sixth embodiment, two laser couplers LC1 and LC2 are incorporated in a face-to-face relationship on a common photodiode IC 1 to share the common photodiodes PD1, PD2 or PD1' for detecting optical signals (in this case, the photodiode PD2), the common microprism 2, and a common optical axis. In this case, the laser coupler LC1 uses the photodiodes PD1 and PD2 to detect optical signals, and the laser coupler LC2 uses the photodiodes PD1' and PD2 to detect optical signals. In the other respects, the sixth embodiment is the same as the laser coupler according to the second embodiment, and its explanation is omitted here.

Here again, when an optical pickup device is made by using the laser coupler according to the sixth embodiment, the objective lens may be integral with or separate from the laser coupler, and both laser couplers LC1 and LC2 may share a common objective lens. Also the sixth embodiment has the same advantages as those of the second embodiment.

Although the invention has been explained by way of some embodiments, the invention is not limited to the illustrated examples, but involves various changes or modifications within the spirit and scope of the invention.

For example, numerical values and materials indicated in the explanation of embodiments are only examples, and different numerical values and materials may be used in the invention.

In the first embodiment, the half mirror may be replaced by a polarizing beam splitter, for example, and the objective lens OL may be made as a separate body from the optical pickup device.

Although the fourth embodiment has been explained as the laser couplers LC1 and LC2 sharing common photodiodes PD1, PD2 and a common microprism 2, and the sixth embodiment has been explained as the laser coupler LC1 or LC2 sharing a common photodiode PD2 and a common microprism 2, a pair of photodiodes PD1 and PD2 may be provided for laser couplers LC1 and LC2 to share a common optical axis, so that the laser coupler LC1 and LC2 share only the microprism 2.

In the first to sixth embodiments, although two laser couplers LC1 and LC2 are incorporated on a common photodiode IC 1 to make up a single laser coupler, three or more laser couplers may be incorporated on a common photodiode IC 1 to form a single laser coupler.

Also when two laser couplers LC1 and LC2 on common substrate 12 are mounted in a parallel alignment in the lateral direction in a common flat package 11, as shown in Fig. 12, and the package 11 is used in an optical pickup device, the same advantages as those of the above embodiments can be obtained. Here again, both laser couplers LC1 and LC2 can use a common objective lens. However, taking the lens field into account, the laser couplers LC1 and LC2 are preferably mounted in close locations up to 100 um, for example. Alternatively, these laser couplers LC1 and LC2 may be arranged in a serial alignment within the common flat package 11. Moreover, three or more laser couplers may be mounted in a common flat package 11.

In Fig. 13, there is schematically illustrated an optical disc system 100 employing anyone of the previously discussed optical devices of the invention. As illustrated, in the optical system 100, an optical device 102 can be employed in which laser coupler LC1, LC2 to LCn are used to read from and write to an optical recording medium 104 (appropriately supported and driven by well known means not illustrated here).

As illustrated, appropriately associated with the optical device 102 is circuitry 106 for driving the laser couplers LC1 to LCn in accordance with well known technology. Additionally, there is provided a selector 108 to switch between the laser

couplers LC1 to LCn as necessary. The selector 108 can take many forms, including a circuit driven by an electronic signal from the driver circuitry 106. A switch 110 may be coupled to the circuitry 106 to enable manual selection of a laser coupler, and, therefore, a format, by a user. Otherwise, the selection may be accomplished automatically by reading information stored on the optical recording medium 104 with one or more of the laser couplers. It is believed that such techniques could be readily implemented by those of ordinary skill in the art.

As illustrated, the selector 108 and driver circuitry 106 may be provided as part of overall circuitry 112 used to operate the optical disc system 100. Such circuitry 112, apart from the inclusion of a selector 108 and the switch means 110 should be well known in the art.

As described above, the optical pickup devices according to the invention are available for writing to and reading from different kinds of optical discs in different formats from each other, and promises miniaturization and easy assembly thereof because the include a plurality of composite optical devices having different read/write specifications.

Because the composite optical devices according to the invention have light emitting elements with different read/write specifications, an optical pickup device using the composite optical devices is available from writing to and reading from different kinds of optical discs of different read/write formats, and can be miniaturized and assembled easily.

Also, it will be readily understood by those of ordinary skill in the art how the various embodiments described above can be modified and/or combined to include more than two laser photocouplers to enable read/write interaction with recording media with more than two read/write formats.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.

IN THE CLAIMS:

1. An optical pickup device comprising:

a plurality of a composite optical devices, each having a light emitting element, a photodetector element and a transparent optical element with a partial reflective plane that are supported on a base body, said composite optical devices having different read/write specifications.

2. The optical pickup device according to claim 1, wherein said light emitting elements of said composite optical devices are different from each other in light emitting wavelength.

3. The optical pickup device according to claim 1, wherein said light emitting elements of said composite optical devices are different from each other in optical output power.

4. The optical pickup device according to claim 1, wherein, said light emitting element, said photodetector element and said transparent optical element in each said composite optical device are disposed so that the optical axis of exit light from said light emitting element and the optical axis of incident light to said photodetector element substantially coincide on said partial reflective plane of said transparent optical element.

5. The optical pickup device according to claim 1, wherein said base body is a semiconductor substrate, said light emitting device is a semiconductor laser, said photodetector element is a photodiode, and said transparent optical element is a prism.

6. A composite optical device comprising:

a plurality of light emitting elements, a photodetector element and a transparent optical element having a partial reflective plane that are provided on a base body, said light emitting elements having different read/write specifications.

7. The composite optical device according to claim 6, wherein said light emitting elements are different from each other in light emitting wavelength.

8. The composite optical device according to claim 6, wherein said light emitting elements are different from each other in optical output power.

9. The composite optical device according to claim 6, wherein each said light emitting element, said photodetector elements and said transparent optical elements are disposed so that the optical axis of exit light from said light emitting device and the optical axis of incident light to said photodetector element substantially coincide on said partial reflective plane of said transparent optical element.

10. The composite optical device according to claim 6, wherein said light emitting elements are arranged side-by-side to align their optical axes substantially in parallel, each said light emitting element having its own said transparent optical element.

11. The composite optical device according to claim 6, wherein said light emitting elements are arranged side-by-side to align their optical axes substantially in parallel, said light emitting elements having a common said transparent optical element.

12. The composite optical device according to claim 6, wherein said light emitting elements are arranged to share a common optical axis and to share a common said optical device.

13. The composite optical device according to claim 6, wherein said light emitting elements are disposed at different heights from the surface of said base body.

14. The composite optical device according to claim 6, wherein said light emitting elements are arranged to share a common optical axis and to share a part of said photodetector element.

15. The composite optical device according to claim 6, wherein said base body is a semiconductor substrate, said light emitting element is a semiconductor laser, said photodetector element is a photodiode, and said transparent optical element is a prism.

16. An optical pickup device comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats.

17. The optical pickup device of claim 16, wherein the photocouplers are mounted within a single flat package.

18. The optical pickup device of claim 16, wherein the photocouplers are formed on a common substrate.

19. The optical pickup device of claim 16, wherein there are two photocouplers and the photocouplers share a common half mirror such that one

photocoupler is aligned with the axis of the direct light passing through the half mirror while the other photocoupler is aligned with the axis of incident light reflected by the half mirror.

20. The optical pickup device of claim 16, further comprising a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium.

21. The optical pickup device of claim 20, wherein the photocouplers share a common reflecting surface of the prism.

22. The optical pickup device of claim 20, wherein the prism has a plurality of reflecting surfaces and the photocouplers use different reflecting surfaces of the prism.

23. The optical pickup device of claim 21, wherein the photocouplers are positioned in side-by-side relationship.

24. The optical pickup device of claim 20, wherein the photocouplers are positioned in over-and-under relationship.

25. The optical pickup device of claim 21, wherein the photocouplers are positioned in confronting relationship on opposite sides of the prism.

26. The optical pickup device of claim 25, wherein the photocouplers are operatively interconnected so as to share in common photo diodes located under said prism.

27. An optical disc system comprising an optical pickup device having a plurality of a composite optical devices, each having a light emitting element, a photodetector element and a transparent optical element with a partial reflective plane that are supported on a base body, said composite optical devices having different read/write specifications, a circuit for driving said optical device and a selector for selecting between said composite optical devices.

28. The optical disc system according to claim 27, wherein said light emitting elements of said composite optical devices are different from each other in light emitting wavelength.

29. The optical disc system according to claim 27, wherein said light emitting elements of said composite optical devices are different from each other in optical output power.

30. The optical disc system according to claim 27, wherein, said light emitting element, said photodetector element and said transparent optical element in each said composite optical device are disposed so that the optical axis of exit light from said light emitting element and the optical axis of incident light to said photodetector element substantially coincide on said partial reflective plane of said transparent optical element.

31. The optical disc system according to claim 27, wherein said base body is a semiconductor substrate, said light emitting device is a semiconductor laser, said photodetector element is a photodiode, and said transparent optical element is a prism.

32. An optical disc system comprising a plurality of photocouplers having different read/write specifications so as to enable the optical device to read from and write to recording media having a like plurality of different read/write formats, a circuit for driving said optical device and a selector for selecting between said composite optical devices.

33. The optical disc system of claim 32, wherein the photocouplers are mounted within a single flat package.

34. The optical disc system of claim 32, wherein the photocouplers are formed on a common substrate.

35. The optical disc system of claim 32, wherein there are two photocouplers and the photocouplers share a common half mirror such that one photocoupler is aligned with the axis of the direct light passing through the half mirror while the other photocoupler is aligned with the axis of incident light reflected by the half mirror.

36. The optical disc system of claim 32, further comprising a prism shared in common by the photocouplers with the prism used by the photocouplers to reflect light toward the optical recording medium.

37. The optical disc system of claim 36, wherein the photocouplers share a common reflecting surface of the prism.

38. The optical disc system of claim 36, wherein the prism has a plurality of reflecting surfaces and the photocouplers use different reflecting surfaces of the prism.

39. The optical disc system of claim 37, wherein the photocouplers are positioned in side-by-side relationship.

40. The optical disc system of claim 36, wherein the photocouplers are positioned in over-and-under relationship.

41. The optical disc system of claim 37, wherein the photocouplers are positioned in confronting relationship on opposite sides of the prism.

42. The optical disc system of claim 41, wherein the photocouplers are operatively interconnected so as to share in common photo diodes located under said prism.

ABSTRACT OF THE DISCLOSURE

An optical pickup device with the capability to read data from and write data to different kinds of optical discs in different formats and a composite optical device used in the optical pickup device. An optical pickup device is made by combining two laser couplers LC1 and LC2 that are designed for optimum read/write specifications for optical discs which are different in format from each other. In one embodiment, two laser couplers LC1 and LC2 are incorporated on a common photodiode IC to form a single laser coupler, and the laser coupler is used in an optical pickup device.

Fig. 1

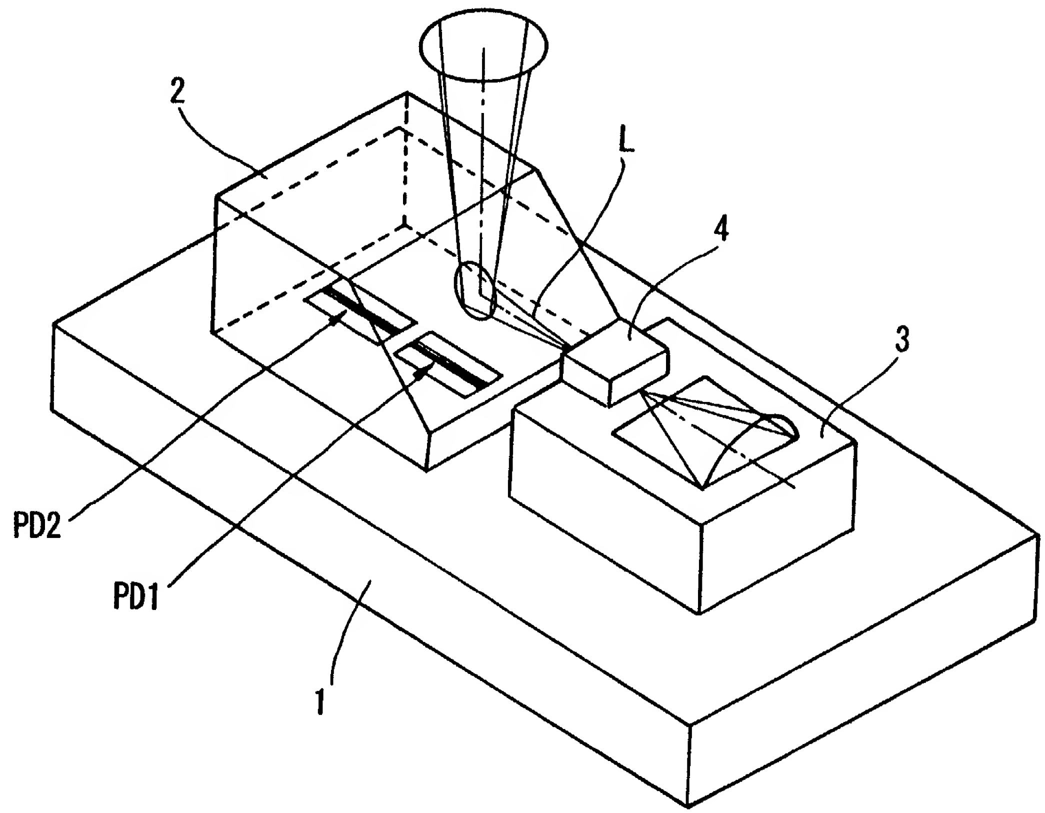


Fig. 2

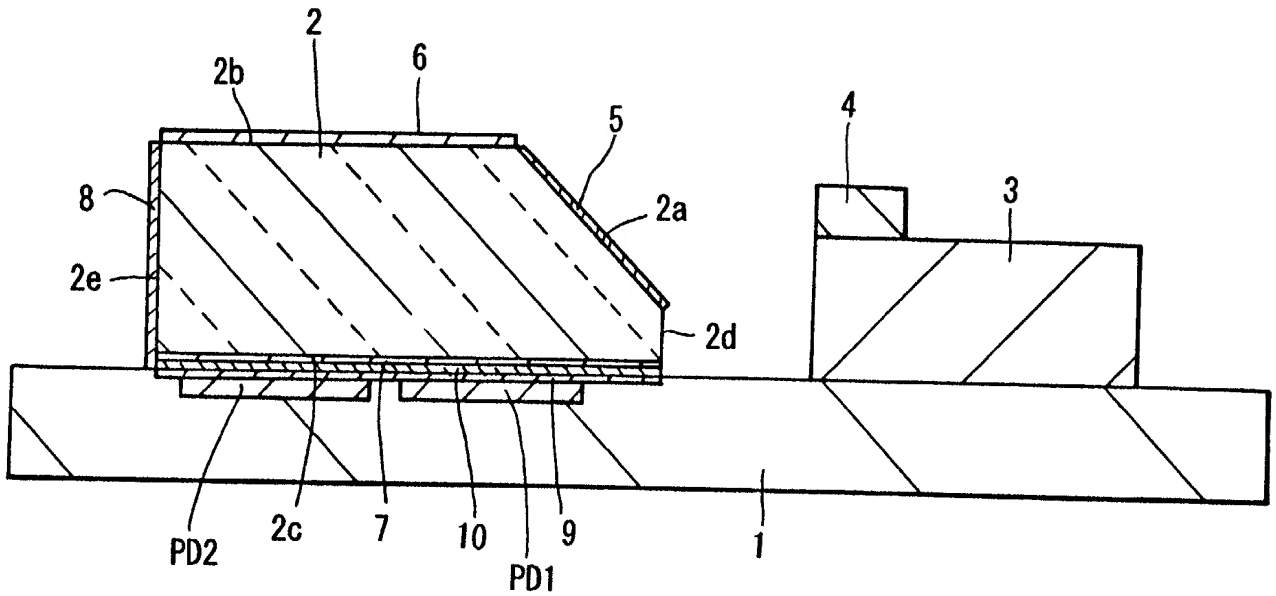


Fig. 3

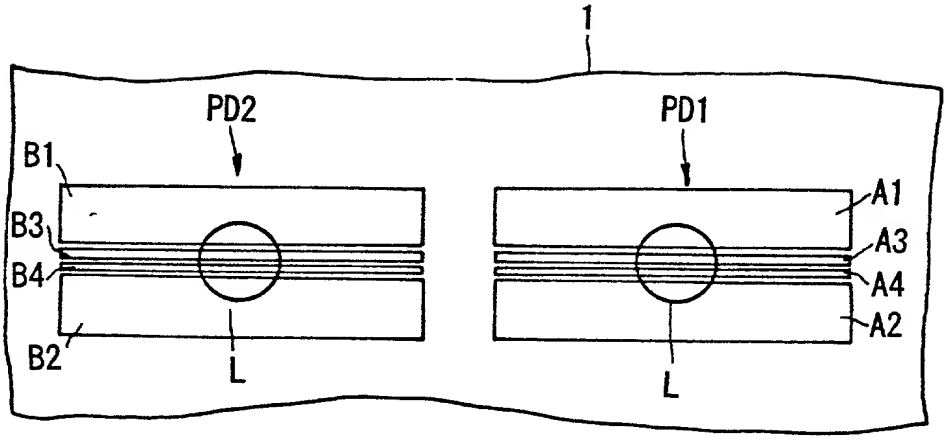


Fig. 4

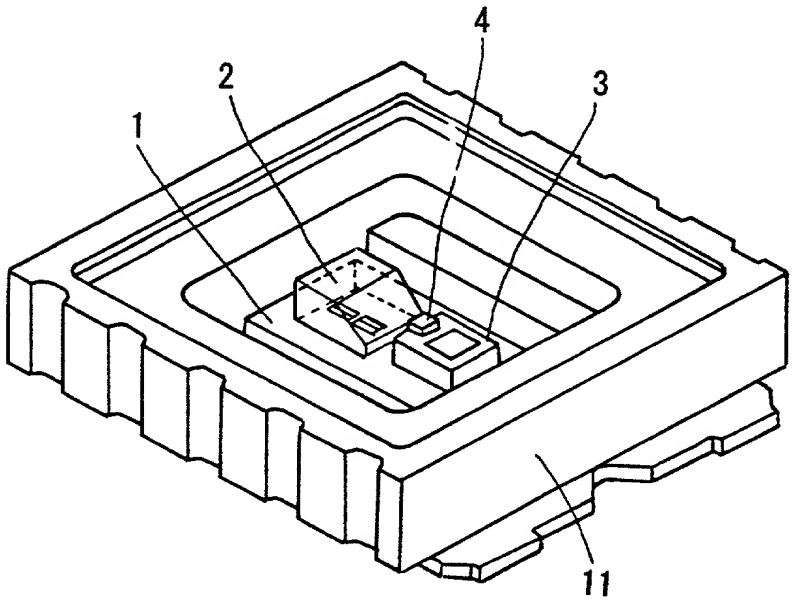


Fig. 5

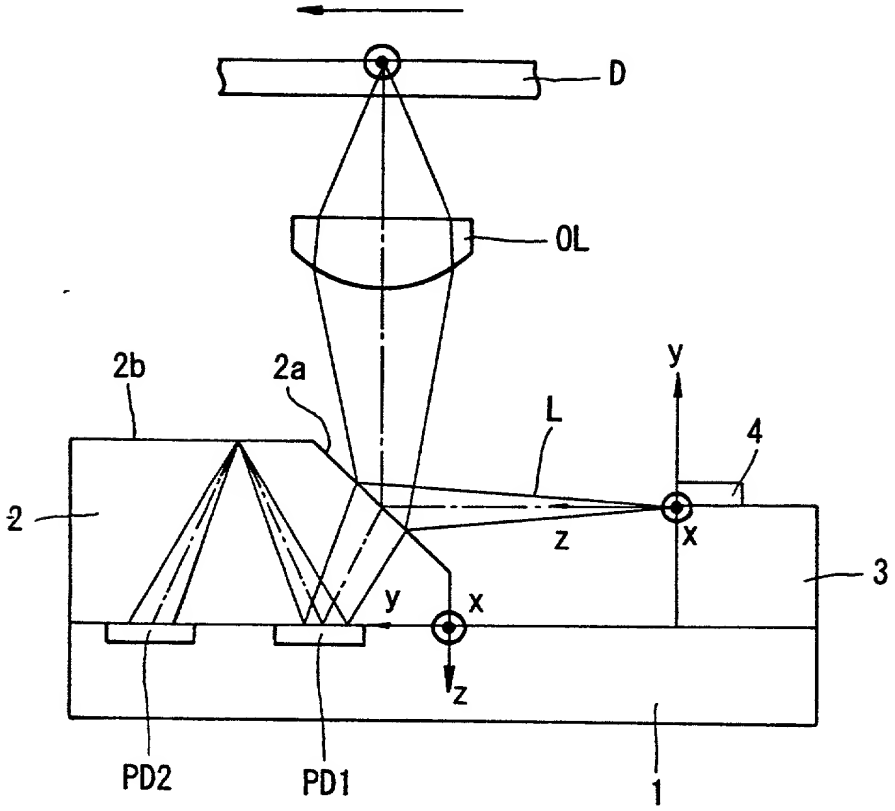


Fig. 6

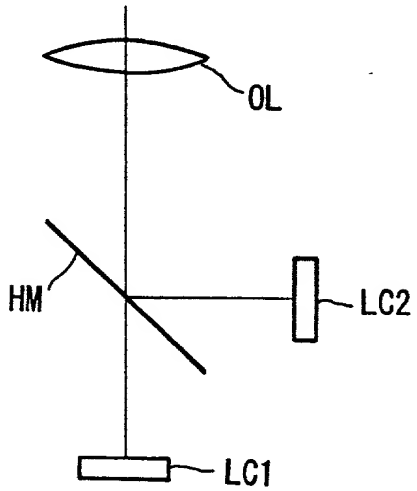


Fig. 7

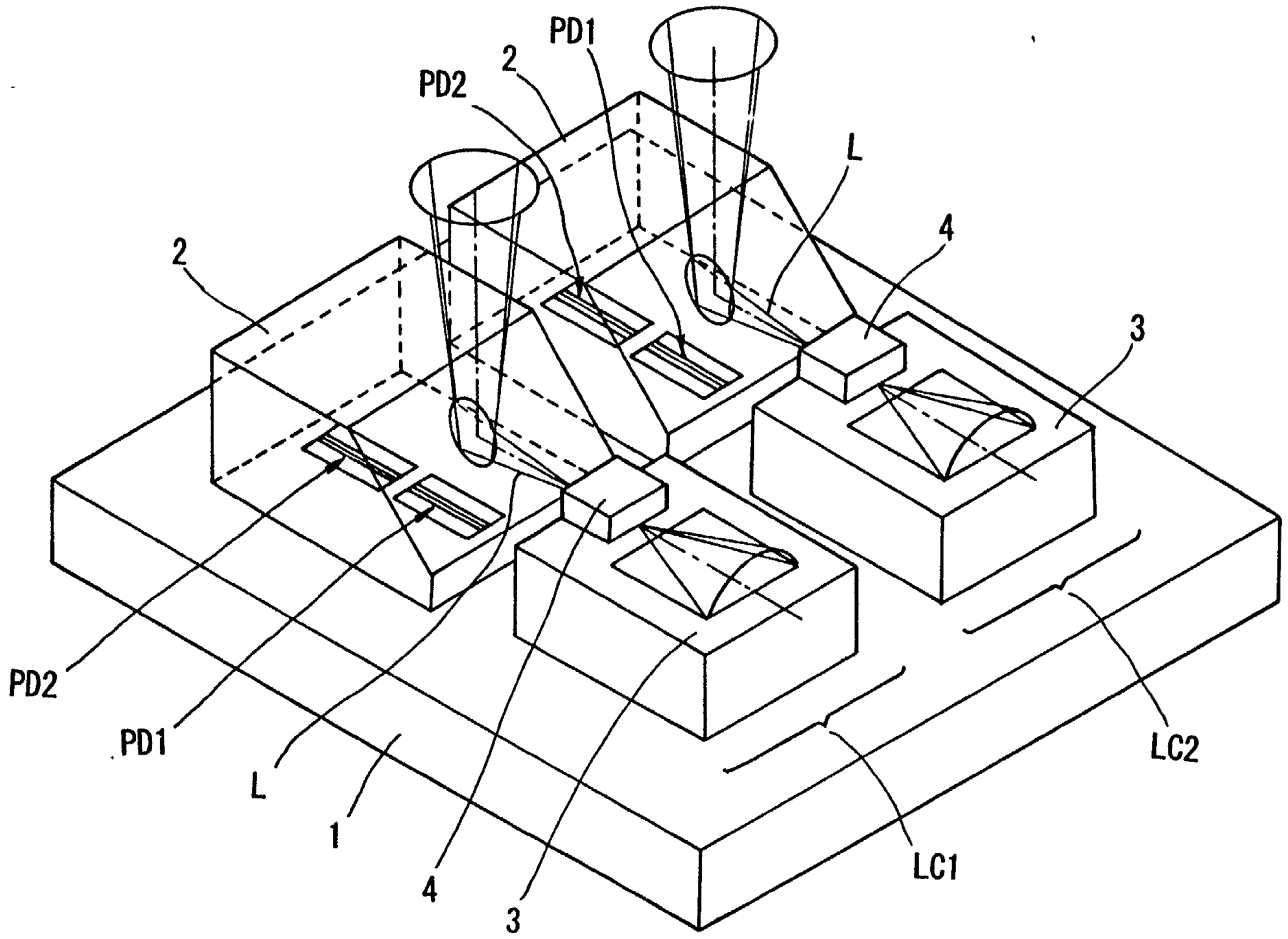


Fig. 8

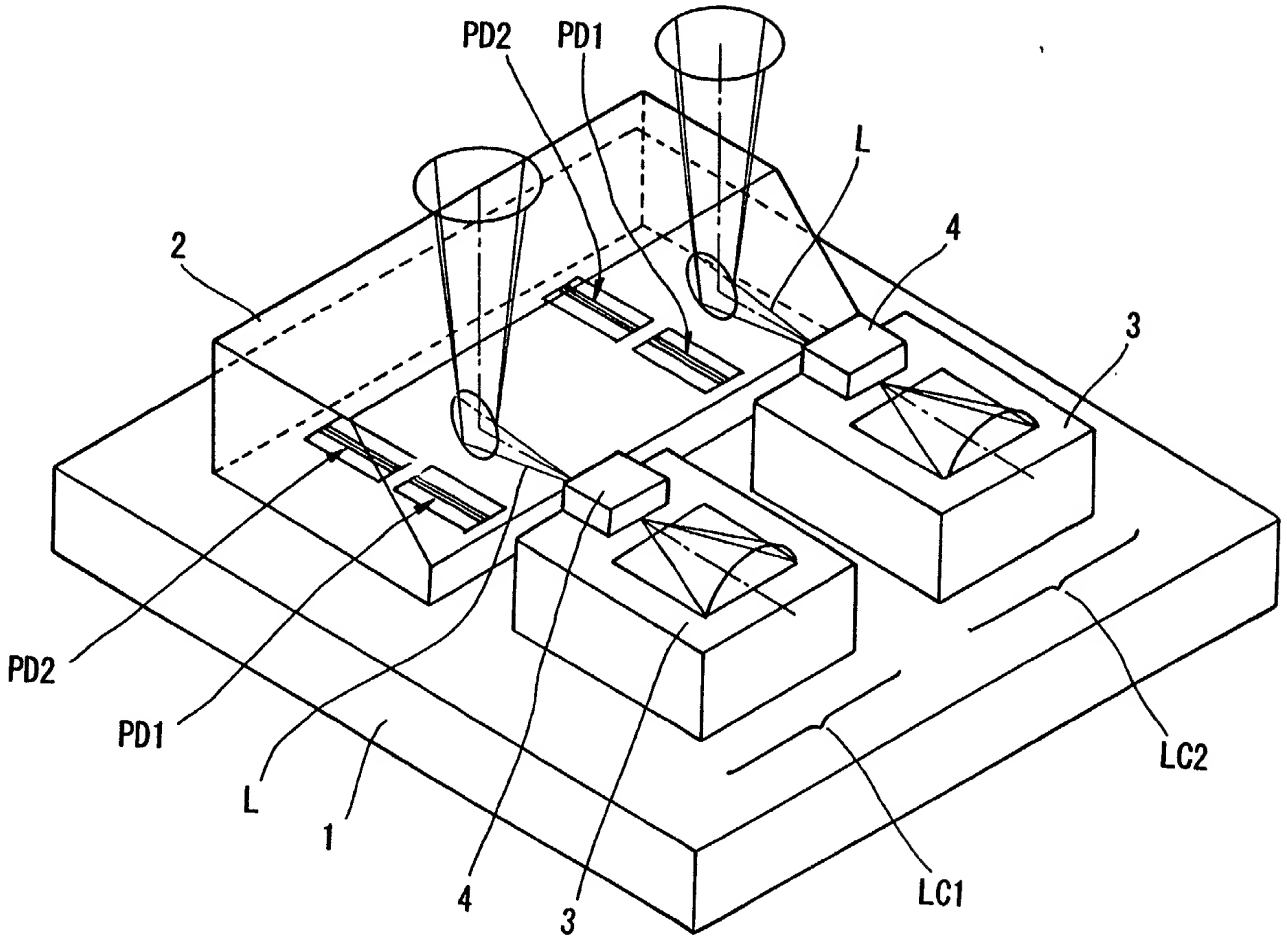


Fig. 9

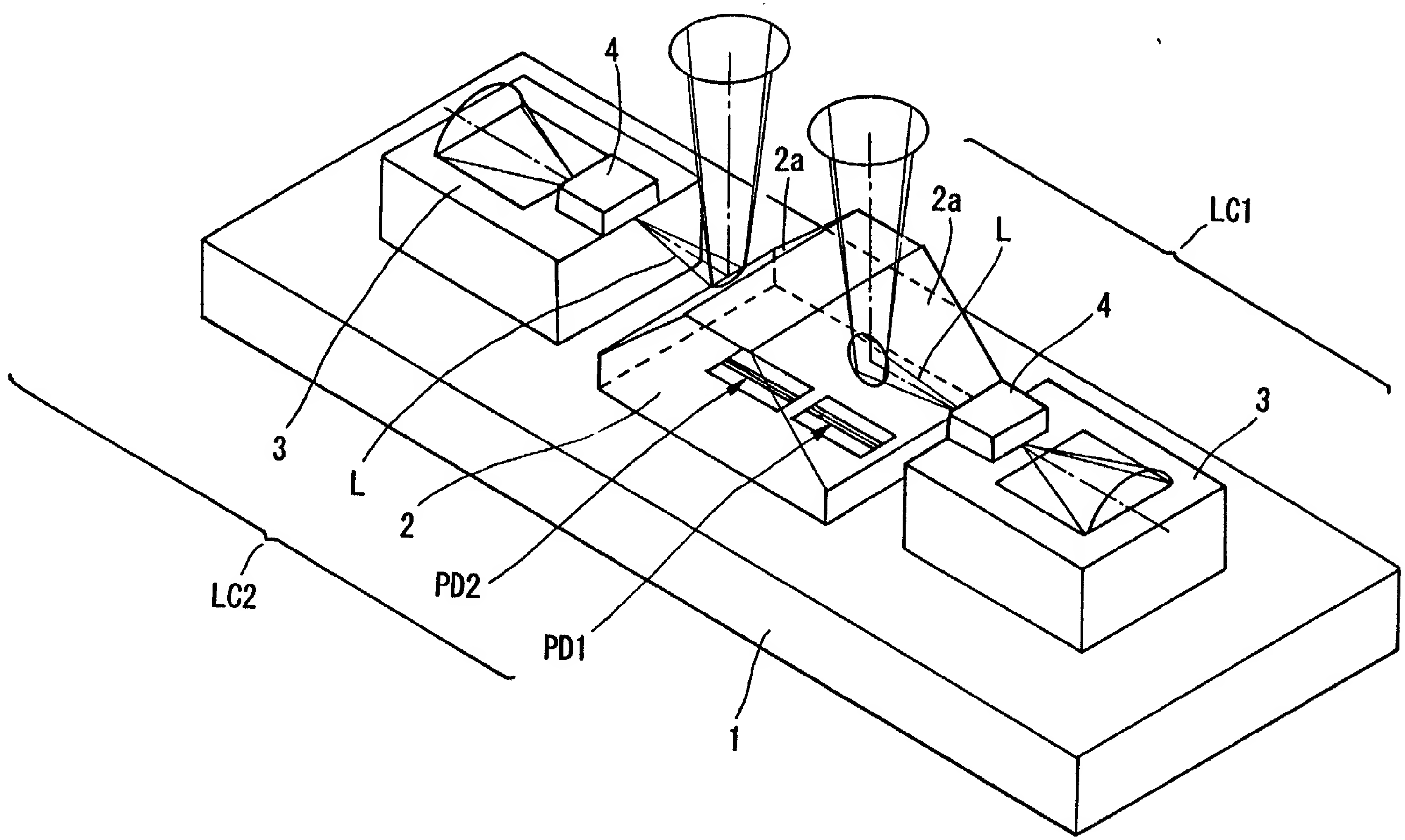


Fig. 10

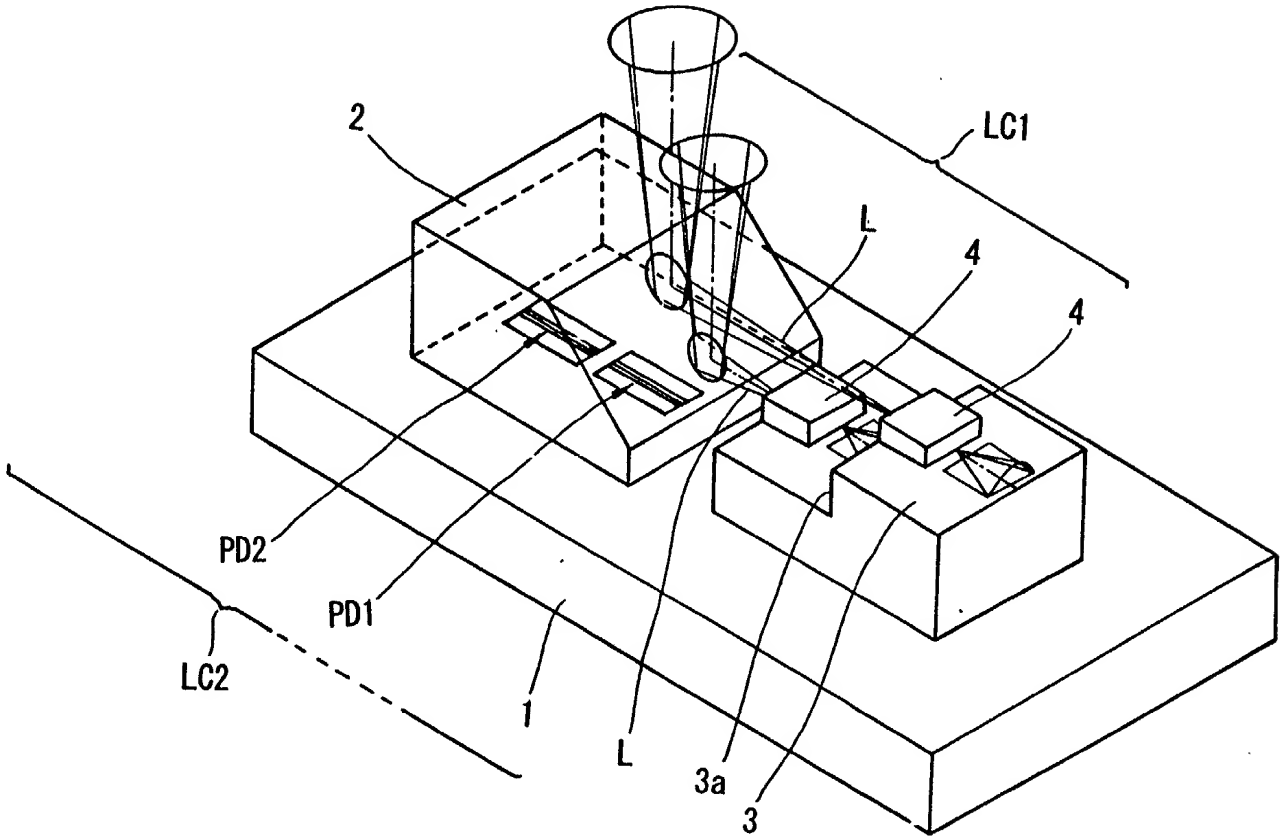


Fig. 11

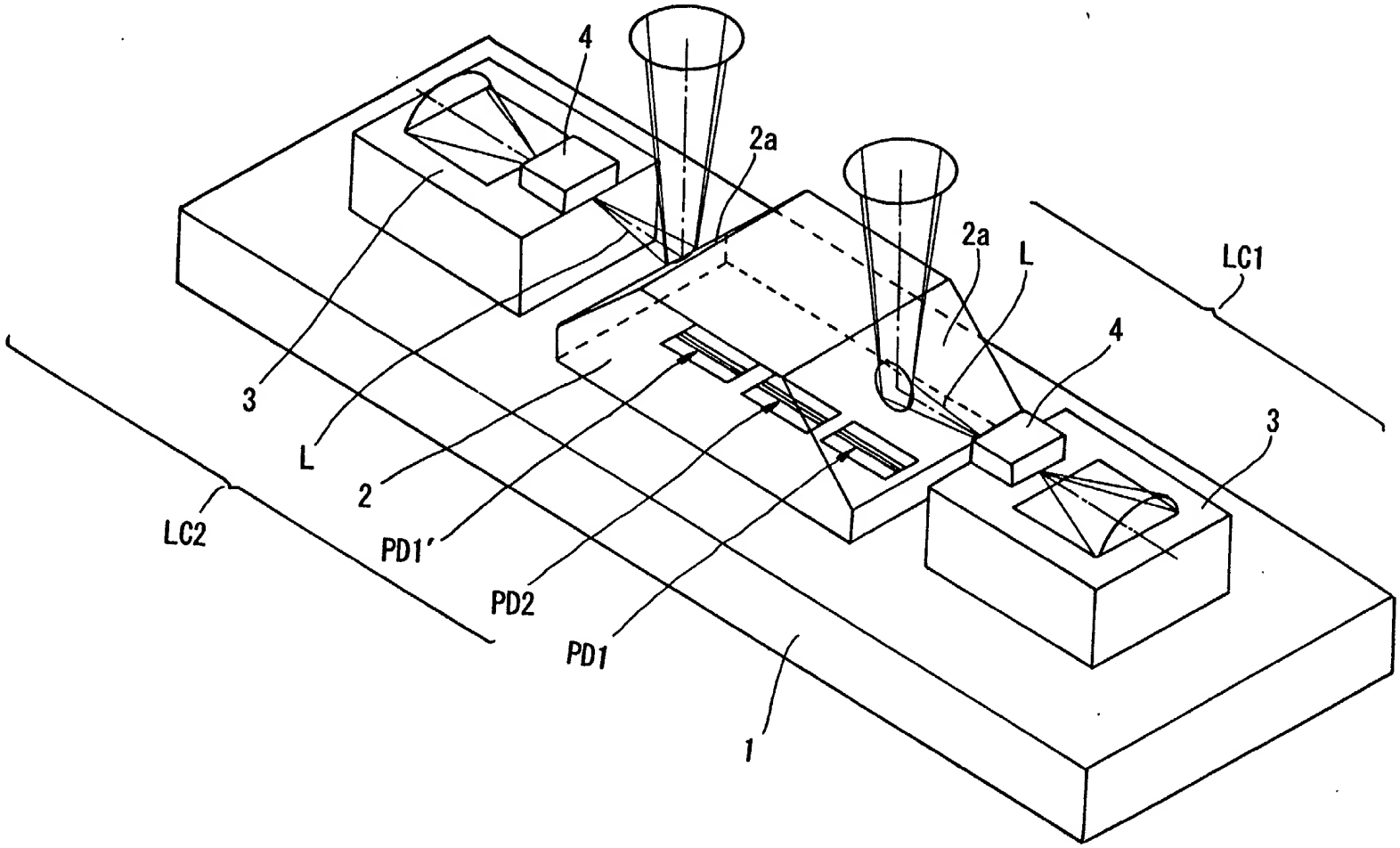


Fig. 12

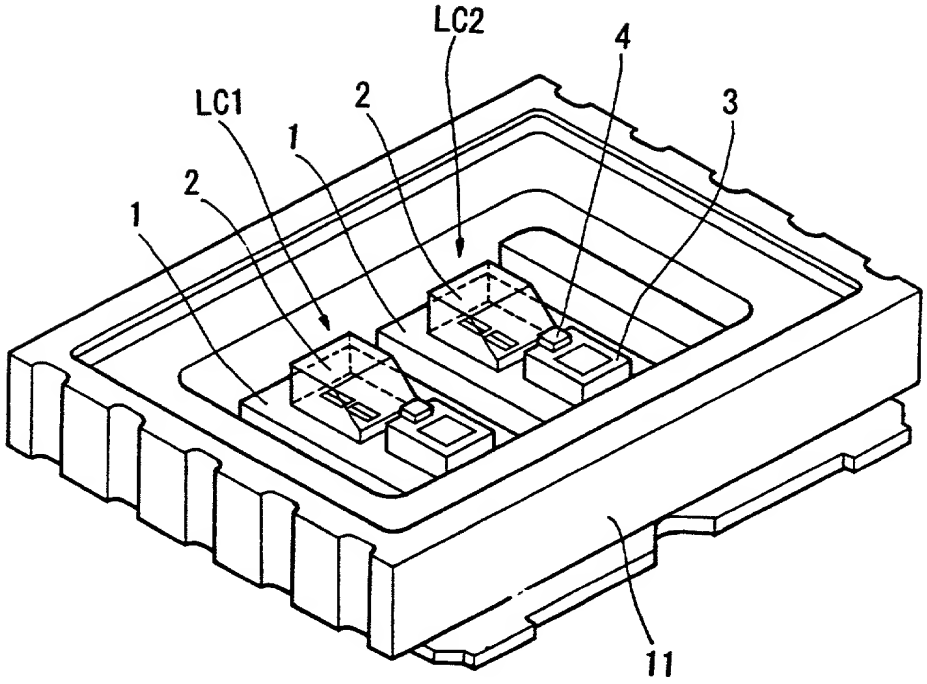
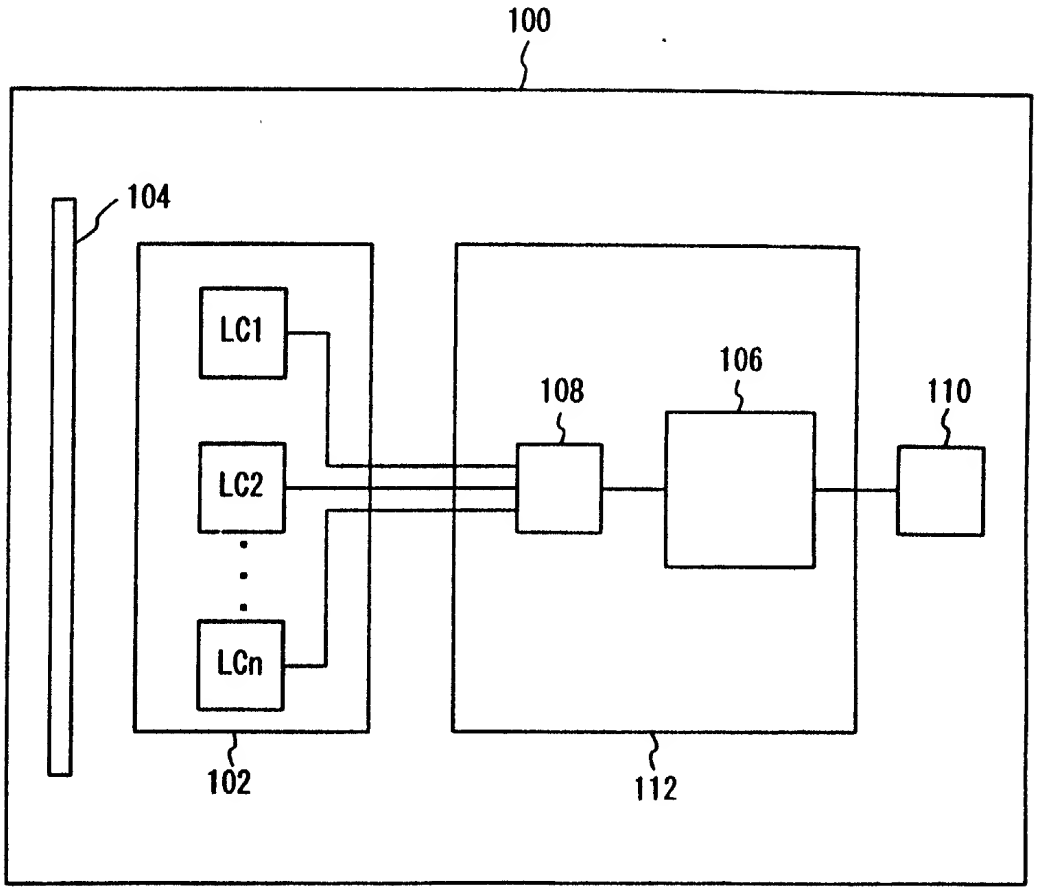


Fig. 13



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

OPTICAL PICKUP DEVICE WITH A PLURALITY OF LASER COUPLERS

Case No. P97,0645 *, the specification of which*

	___	*is attached hereto.*
(check one)	X	*was filed on* May 27, 1997 *, as Application Serial No.* 08/863,434 *and was amended on* _____ *(if applicable)*

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent Office all information which is known to me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a).[1]

I do not know and do not believe this invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and I believe that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as identified below:

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below

Prior Foreign Application(s)

Number	*Country*	*Date*
P08-154839	Japan	May 27, 1996

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[1] *(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and*

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the above listed application on which priority is claimed:

Prior Foreign Application(s)

Number	*Country*	*Date*

If no priority is claimed, I have identified all foreign patent applications filed prior to this application:

Prior Foreign Application(s)

Number	*Country*	*Date*

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my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and direct that all correspondence be forwarded to:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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